Potential effects of alternative ground-water management practices on streamflow, with examples from Southern New England

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Streamflow at any location is the integrated result of numerous factors:

- Climate (precip and evapotranspiration)
- Hydrologic position (headwater vs. downstream reach)
- Geology and soils (permeability and storage properties)
- Land use & land cover (forested, open, residential, commercial/industrial)
- Water use patterns (withdrawals and return flows)

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Water use patterns affect streamflow through:

• The rate, timing, and hydrologic position of withdrawals and return flows with respect to streams.

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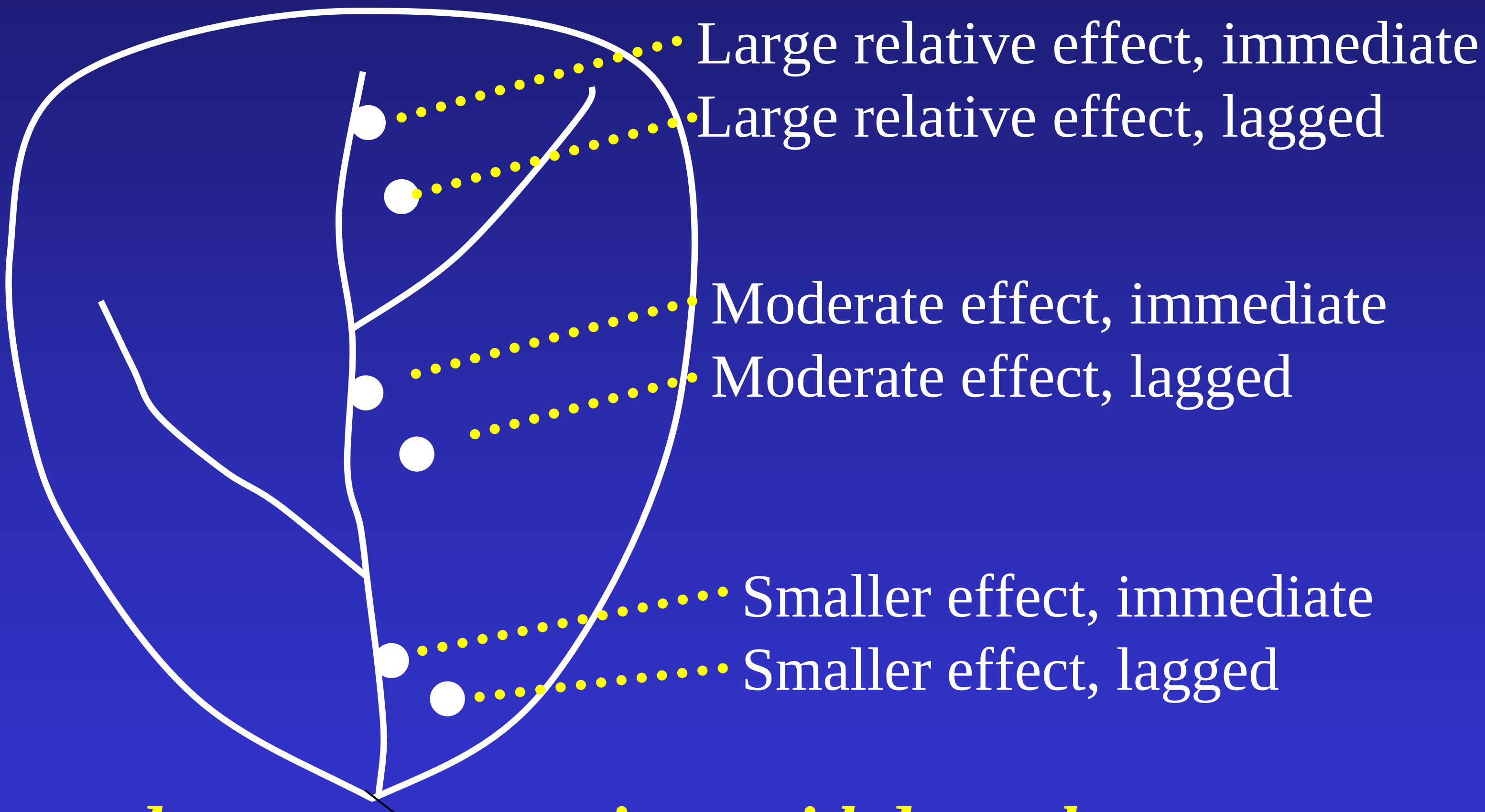
Effects of ground-water pumping on streamflow depend on the hydrologic position of the pumping well in the basin, and (in cases where the pumping rate varies seasonally) the distance to the stream.



As you move downstream, a given withdrawal represents a smaller fraction of the pre-development streamflow.

Over the long term, wells obtain their water from two sources:

- Capture of aquifer recharge (captured baseflow)
- Induced infiltration from streams or other water bodies

On a seasonal basis, transient depletion of aquifer storage can also be an important source of water to wells.

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Question 1:

Can reduction of spring/summer pumping rates at near-stream wells significantly affect summer streamflows in a typical situation?

Real-world examples:

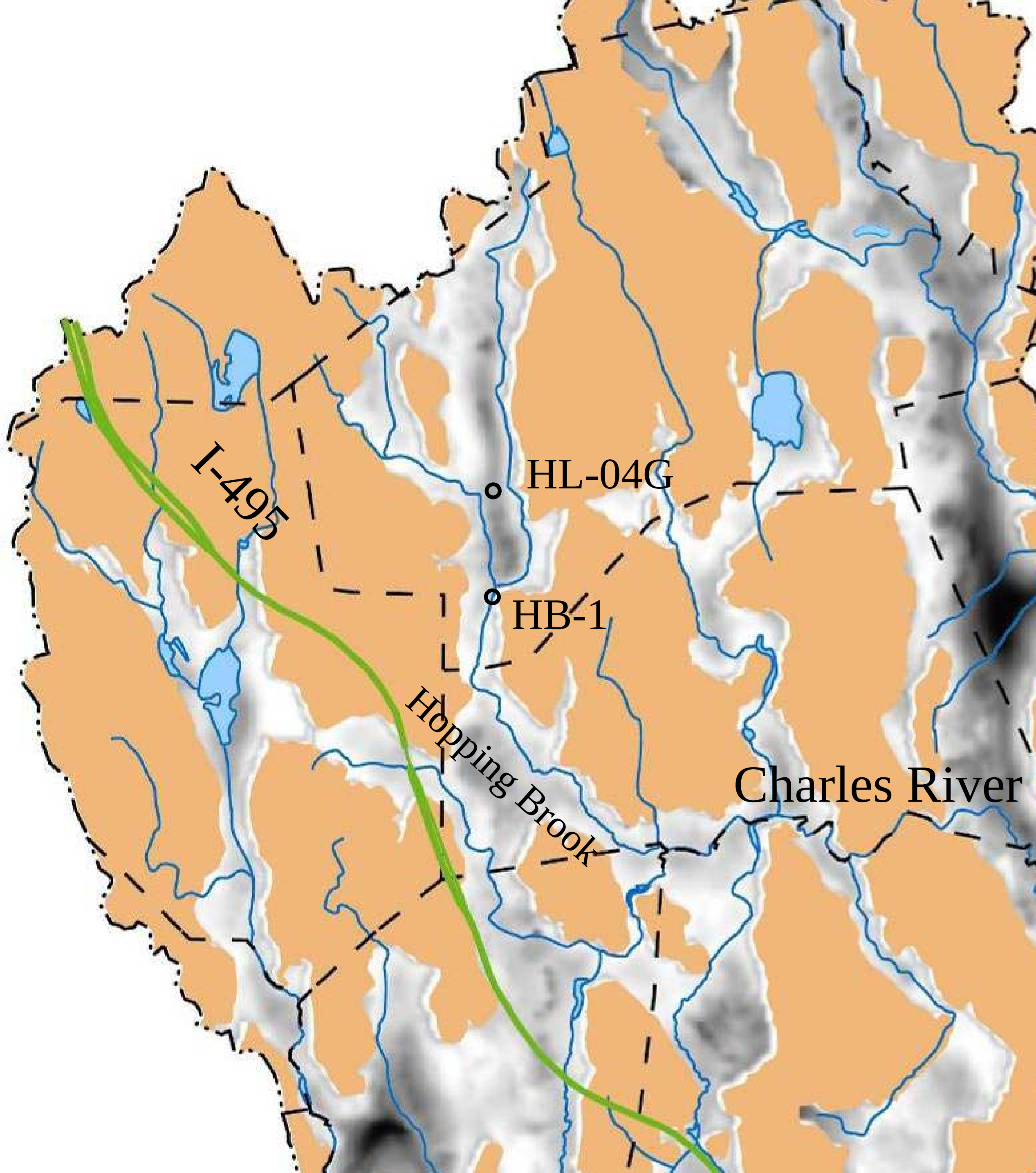
Hopping Brook, Upper Charles River Basin

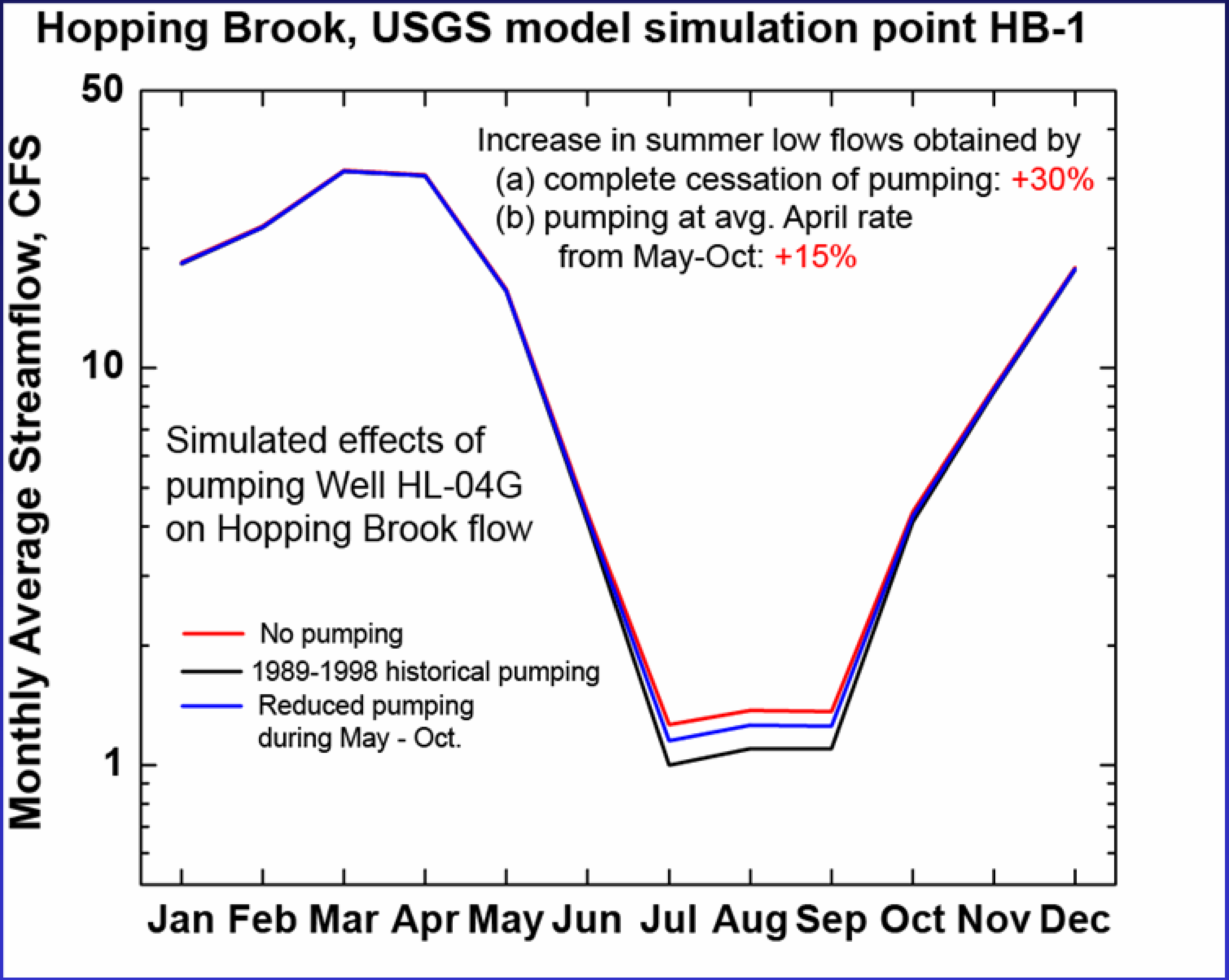
Ipswich River at So. Middleton

Hopping Brook Well HL-04

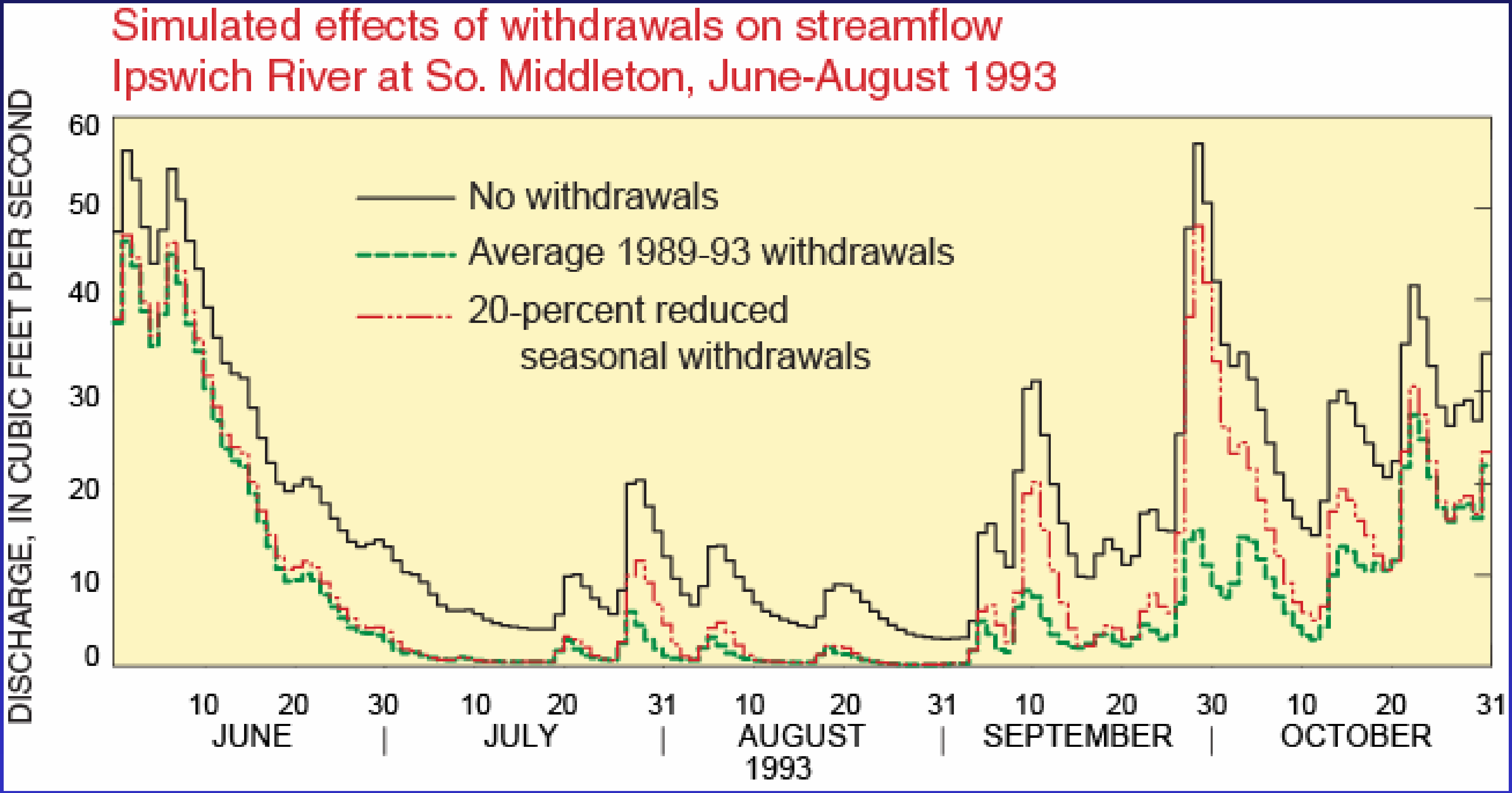
~ 450 ft. from stream reach

Streamflows simulated at location HB-1.



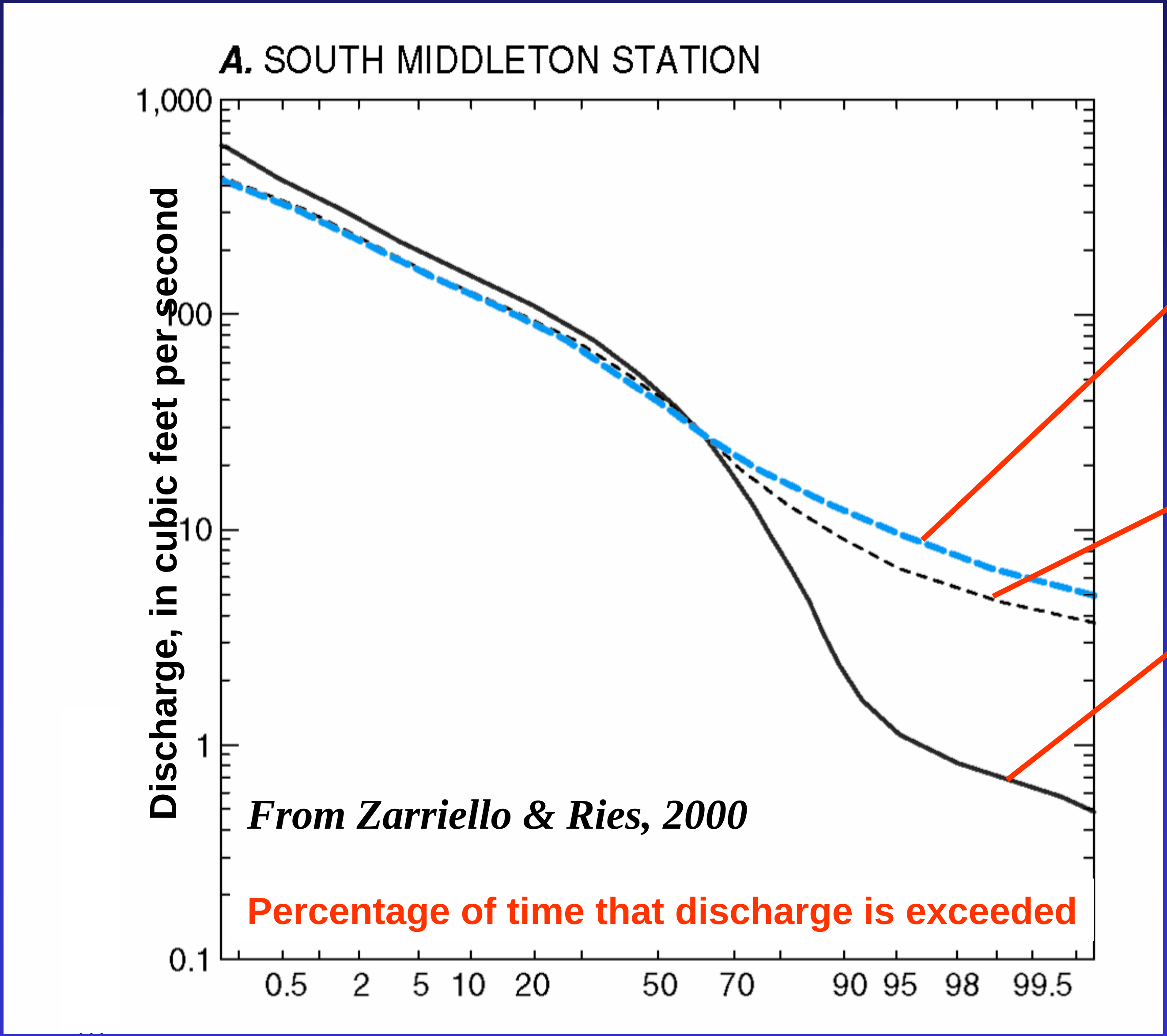


Based on simulations of Eggleston (2003)



From Zarriello (2001)

Altered flow regime: Ipswich River at So. Middleton:



Simulation results for:

No withdrawals, undeveloped land use

No withdrawals, 1991 land use

1989-93 withdrawals, 1991 land use

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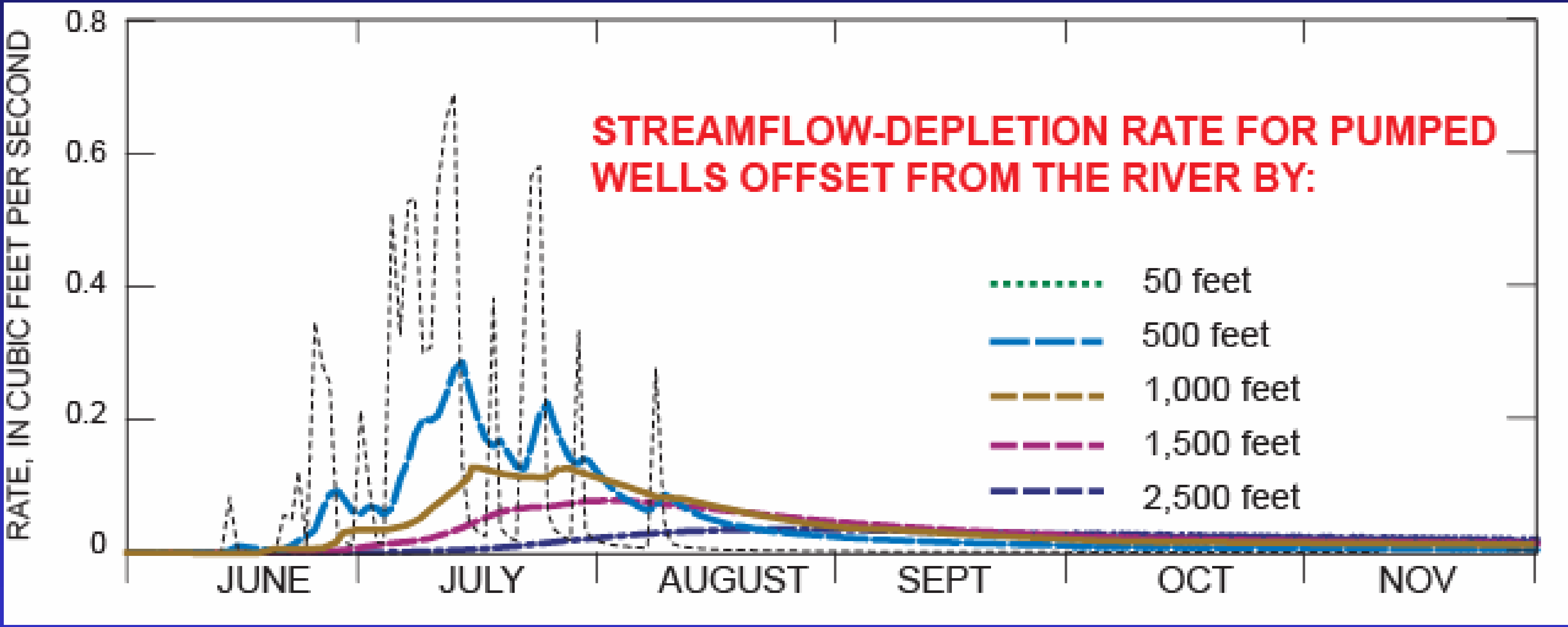
Question 2:

Can use of wells away from streams significantly reduce depletion of summer streamflows?

Real-world example:
Usquepaug River, Rhode Island

(Zarriello and Bent, 2004)

Effect of well distance from stream on streamflow depletion:



Streamflow depletion is damped and lagged, as well distance increases, although the same amount of streamflow depletion occurs over the long-term.

Streamflow depletion can be mitigated by:

1. Bringing withdrawals more into phase with the recharge cycle (i.e., reduce spring/summer withdrawals).

2. Reducing withdrawals from streamside wells; and relying upon aquifer (or reservoir) storage away from streams in summer.

3. Minimize export of water and wastewater.

Calibrated models are useful for testing various options

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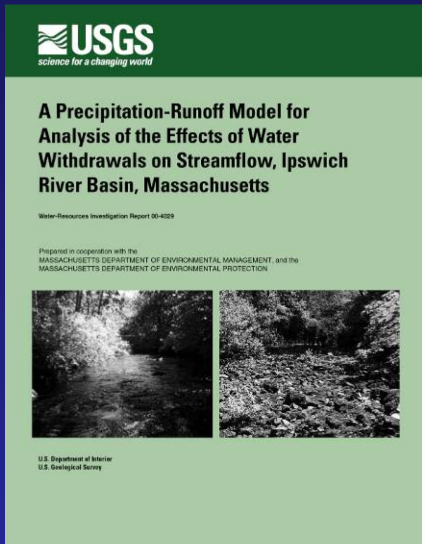
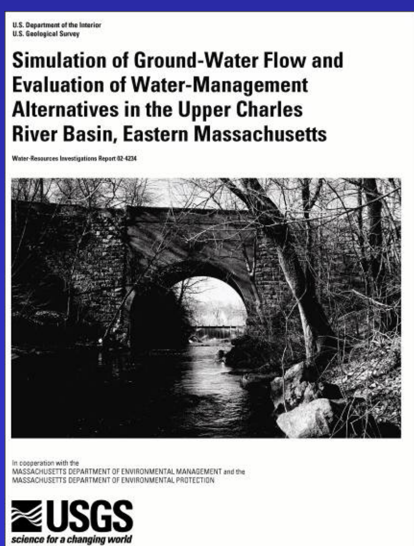


Recently completed USGS Basin Modeling Reports:

- Ipswich Basin
- Upper Charles Basin
- Assabet Basin
- Mid and Lower Cape



http://ma.water.usgs.gov
(click on publications)

Reports cited:

Eggleston, J., 2003, Evaluation of Strategies for Balancing Water Use and Streamflow Reductions in the Upper Charles River Basin, Eastern Massachusetts: USGS WRIR 03-4330 http://pubs.usgs.gov/wri/wri034330/

Zarriello, P., 2001, Effects of water-management alternatives on streamflow in the Ipswich River Basin, Mass., USGS OFR 01-483. http://pubs.usgs.gov/of/2001/ofr01483/

Zarriello, P. and Ries, K., 2000, A Precipitation-Runoff Model for Analysis of the Effects of Water Withdrawals on Streamflow, Ipswich River Basin, Mass. http://pubs.usgs.gov/wri/wri004029/

Reports cited (continued):

Zarriello, P.J., and Bent, G.C., 2004, A precipitation-runoff model for the analysis of the effects of water withdrawals and land-use change on streamflow in the Usquepaug–Queen River Basin, Rhode Island: USGS SIR 2004-5139, 75 p. http://pubs.usgs.gov/sir/2004/5139/